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Superfast domain wall motion and growth of dendrite domains in ferroelectrics. Analogy with crystal growth

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The experimental study of the formation and growth of dendrite domains and superfast shape transformation of the concave polygonal domain after merging to the convex one in uniaxial ferroelectric will be presented and described. The obtained effects will be considered using analogy between kinetics of ferroelectric domains and crystal growth.

The evolution of the isolated ferroelectric domains during polarization reversal in uniform electric field was studied in congruent lithium niobate $LiNbO_3$ (CLN) single crystals by *in situ* optical imaging with high temporal resolution. The static domain patterns were imaged at the crystal surface by scanning electron microscopy and in the crystal bulk by confocal Raman microscopy and Cherenkov-type second harmonic generation. Various domain shapes including regular convex polygons, stars and dendrites have been obtained for switching in temperature range and in the samples with artificial dielectric layer.

The growth of dendrite domains has been obtained at the elevated temperatures (above 220 ºC) in the plates covered by artificial dielectric layer [3]. The field dependence of the dendrite envelope was revealed. The topological instability leading to appearance of the dendrite shapes was attributed to dominating of the stochastic nucleation in CLN at elevated temperatures [1, 2].

The kinetic approach to domain growth based on generation of steps (pairs of kinks) and motion of kinks along the wall has been applied [4]. It was proposed that the step generation rate and kink motion velocity are determined by the excess of the local value of the sum of the external field and residual depolarization field over the threshold value.

The domain shape change due to screening retardation and formation of the trail of residual charges was demonstrated by computer simulation [4]. It was shown that the determined step generation at the polygonal domain vertices and anisotropic kink motion dominated at temperatures below 200 ºC, whereas the stochastic generation is observed at the temperatures above 200 ºC. The convex hexagon domain shapes have been observed for effective screening of depolarization field, whereas the irregular polygons and stars screening retardation leads to the.

The first detail experimental study of the transformation of the concave polygonal domain appeared after merging to the convex one, named as “shape stability effect”, has been realized [5]. The convex growth of hexagonal domains was governed by the slowest domain walls, while the concave growth after domain merging – by superfast walls with three orders of magnitude higher velocity. The analysis of convex and concave domain growth allows reconstructing experimentally the v-plot (kinetic Wulff plot) for domain wall motion [6].

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